# Deployment of Multi-Hour Ability to Overlay Construction Network for Future Internet

Sung Won Ahn
Department of Computer Science and Engineering
Korea University.
Anam-dong Seongbuk-gu,
Seoul, Korea 136-710 Korea
+82-2-3290-3639
swahn@os.korea.ac.kr

Chuck Yoo
Department of Computer Science and Engineering
Korea University.
Anam-dong Seongbuk-gu,
Seoul, Korea 136-710 Korea
+82-2-3290-3198
hxy@os.korea.ac.kr

## ABSTRACT
Various path-diverse overlay construction schemes have been adapted widely for future internet technology in order to overcome the bandwidth scarcity and achieve efficient resource usage. In this paper, we propose a quite intuitional approach that deploys multi-hour ability to the path-diverse overlay construction for video streaming. Multi-hour ability exploits a simple phenomenon that bandwidth utilization varies from hour to hour. We show that multi-hour ability yields an important principle in the overlay construction, and as a result, each peer expects to achieve better quality of streaming.

## Categories and Subject Descriptors
Geographic Routing and Location-Aware Services

## General Terms
Designing Architecture, Routing Method

## Keywords
Multi-Hour Ability, Overlay Network, P2P, Future Internet

## 1. INTRODUCTION
P2P(peer-to-peer) is often appeared topic as a new paradigm that breaks away from the existing server-client network for future internet. P2P has been takes up a considerable amount of Internet traffics [3] on these days, and continuously, has gained a firm foothold in various applications, e.g., file sharing, distributed computing, instant messenger, and video streaming. In P2P application, there is a group of peers, and rather than having just the physical connection with other peers, they are connected via an applied logical connection, that is, overlay. Generally, the legacy single path routing scheme cannot provide enough bandwidth to the P2P applications, such as video streaming, that require relatively high bandwidth. Thus various path-diversity schemes have been proposed where each peer pulls the data it wants from multiple peers simultaneously [4,5,6]. However, the construction of path-diverse overlay requires huge measurements and maintenance cost in order to meet the streaming quality and load balancing constraint. Furthermore, it still remains as a big challenge to solve the problem of the late playback, especially under the situation of flash crowd [7].

In a general human life, it is natural that there are more activities in daytime than midnight, and thus it is not difficult to predict that Internet bandwidth usage will be much higher in daytime. This natural phenomenon leads us to envisage a routing protocol that reflects this time-dependent bandwidth usage that varies from hour to hour within a day; it is said that the routing protocol has multi-hour ability. Multi-hour behavior of Internet traffic is observed especially when the network spans over multiple time zones and has different peaks for different demands at different hours, i.e., non-coincidence of busy hours [1, 2].

In fact, exploiting non-coincidence of busy hours along with dynamic (time-dependent) routing, the first ever dynamic routing for the telephone network called dynamic non-hierarchical routing (DNHR), was deployed in the mid 1980s spanning the continental U.S.; furthermore it was estimated that network design for the DNHR network was achievable at savings in the order of 16% compared to a network with (previously used) old hierarchical routing while providing same grade-of-service [1].

In this paper, we show that the multi-hour ability can be provided to an overlay construction for P2P video streaming since the overlay for certain live streaming applications also may span over multiple time zones, e.g., live broadcasting of European soccer matches, and it is easy to deploy a new feature to the overlay construction. If the overlay spans over multiple time zones, it is highly probable that large part of peers locate in the daytime zone. Because the daytime may vary in accordance with the streaming contents type. In this situation, the peers in the daytime zone attempt to download from other peers in the same time zone since most existing algorithms for the overlay construction give high priority to the proximity [11,12,13], i.e., each peer tries to choose its up-loaders among the peers that are close to itself. Therefore it is feasible that the peers – relatively small number of peers - in the time zone of midnight may not be chosen as an up-loader, and as a result, the uploading bandwidth of these peers may be underutilized. In this paper, we propose a scheme to exploit this underutilized bandwidth.

## 2. INVESTIGATION OF MULTI-HOUR BEHAVIOR
In order to investigate the multi-hour behavior in general Internet, traffic load is measured for every hour during a day; this is done especially to take advantage of non-coincidence of busy hour (peak) loads between different node pairs in the network. These measurements give the routing protocol multi-hour network dimensioning (or sizing) that involves determination of network capacity at minimum cost that can meet the traffic demand at any time during the day by considering multi-hour behavior [1, 2].

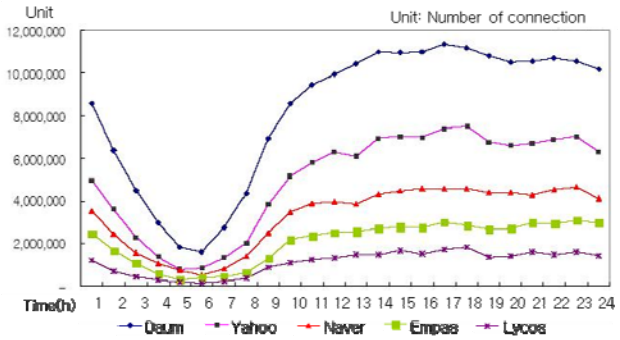


**Figure 1. The number of connections according to time measured at some major Internet portal sites in Korea**

The telephone network in U.S continent is a good example where the multi-hour ability has been deployed. Consider telephone traffic at 8:00 am in the Eastern Standard Time. We can expect traffic to increase between east-coast cities (due to offices opening at 8:00 am), but we are unlikely to see much cross-country traffic to the west cost, or between cities in the west coast where the local time is 5:00 am in Pacific Time zone. This suggests that a call at around 8:00 am in the Eastern Standard Time zone can conceivably be routed via a city located in the west coast. This routing incurs a disadvantage of long-distance but can ensure better connectivity.

Figure 1 plots the number of connections according to time measured at some major Internet portal sites in Korea [15]. As shown in this figure, it is observed that there are relatively much more connections from 12:00 pm to 8:00 pm.

Figure 2 shows the variations of Internet loads measured at the core routers in Asia and North America that are opposition side on the earth [8]. We observe that there are differences in traffic loads between these continents on every hour, and on each continent between daytime and midnight.

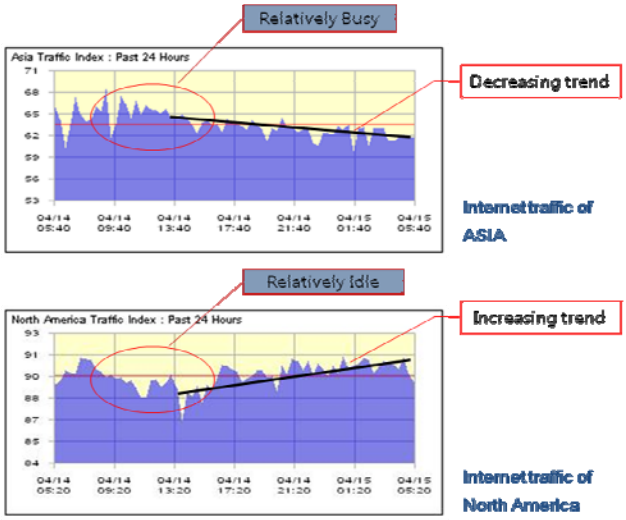


**Figure 2. Variation of internet load between different continents**

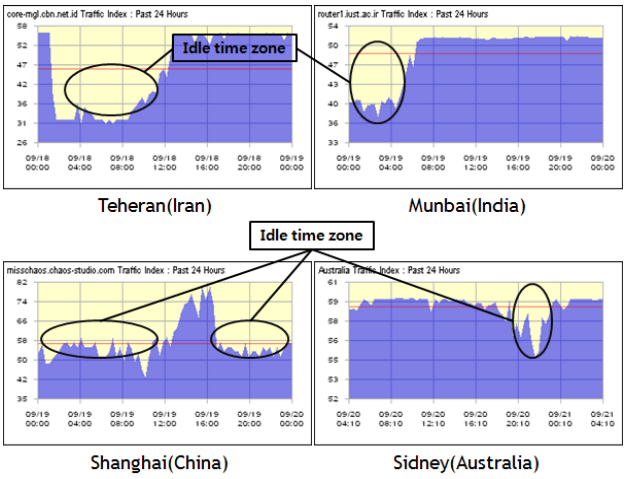


**Figure 3. Varied internet loads of the cities in the world**

For more remarkable example, figure 3 shows varied internet traffic of the major cities in the world. As shown in figure 3, there are more prominent idle time zones. Because these regions are not widely spread relatively compare with example of figure 2. The time zone of cities is narrow by geographically.

## 3. DEPLOYMENT OF MULTI-HOUR ABILITY

For the deployment of multi-hour ability to P2P video streaming, we deploy a central overlay manager that keeps the information about the general Internet traffic load in busy and idle time at each time zone beforehand. We explain this deployment using an example shown in Figure 4.

The busy and idle time can be estimated through the contents type or measurement. Subsequently, if the overlay manager receives a connection request from a peer, it retrieves the peer's time zone and the information of its busy and idle time. If the peer locates in busy time zone, the overlay manager introduces some peers that locate in the idle time zone as well as peers close by.

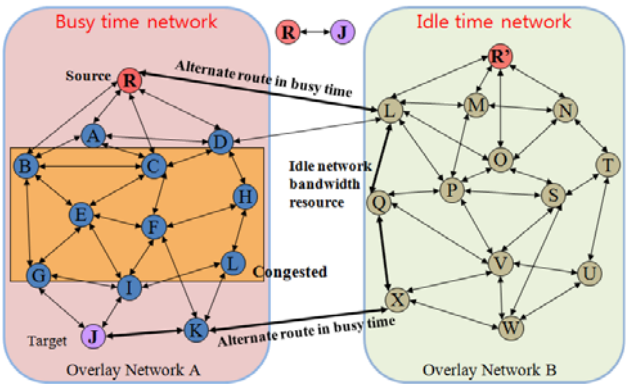


**Figure 4. Example scenario of multi-hour ability**

Then the peer makes path-diverse connections with the peers altogether in the idle time zone and close by. If all the current peers in the idle time zone have already enough uploading connections, the overlay manager may introduce only the peers close by. In order to exploit underutilized bandwidth, we let some peers in the busy time zone make more path-diverse connections with the peers in the idle time zone.

## 4. SIMULATION ANALYSIS

It is sure that multi-hour ability will produce some roundabouts and incur redundant delay consequently. However, it is measured that the regional difference does not incur big delay in packet propagation. According to [4], the delay between Sweden and UC Berkely, US is measured only 199ms. This delay is tolerable to live but not interactive streaming applications. But it can improve the reducing delay between difference regional network by using IP tunnelling techniques.[10] It can improve inter-domain forwarding performance.

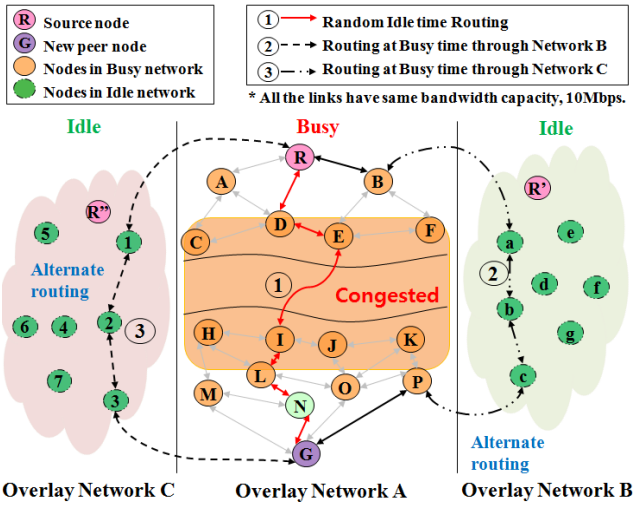


**Figure 5. Simulation scenario**

For the simulations, we assume 3 networks that lie in different time zone as shown in Figure 5. We let each network include 100 peers, and let each peer have overlay connections with more than one nearby peers. In addition, we let some peers have connections with the peers in other adjacent networks. We assume that every link has the bandwidth of 10Mbps uniformly, and set 20ms as the delay on every intra-network link and 200 ms on every inter-network link. Then we let Node R be the original streaming server, and node G is a new upcoming peer. In this situation, we assume that G can download the streaming through the path 1, 2, or 3, and then we measure the downloading throughput of each path towards G. Moreover, in order to make Network A busy and the others idle, we generate random background traffics of 1.0 ~ 3.0Mbps in Network A and 0.1 ~ 0.5Mbps in Network B and C. We also generate the inter-network traffics of 0.5 ~ 1.0Mbps. We let the original streaming server issue CBR (Constant Bit Rate) streaming with rate of 5.0Mbps.

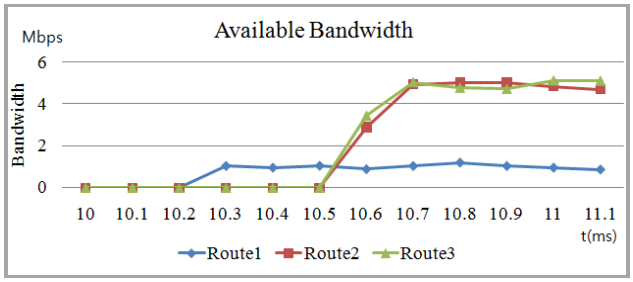


**Figure 6. Available downloading rate in peer G**

Figure 6 plots the downloading throughput of each path measured at peer G. We let the original server start streaming at 10 sec. As illustrated in this figure, we observe that the routes via idle networks provide better throughput, however, the streaming data arrives at peer G 300ms late since the route via idle networks are longer than the optimal path, i.e., Route 1.

## 5. CONCLUSITION AND FUTURE WORK

In this paper, we propose a deployment of multi-hour ability to an overlay construction in P2P video streaming. We investigate that there are relatively high bandwidth usage in the time zone of busy time, and on the other hand, low bandwidth usage in the time zone of idle time. By exploiting this natural phenomenon – called multi-hour ability, we can detour the traffic generated at busy network via idle network. Therefore the multi-hour ability provides a good and simple principle not only for determining path diverse routes in P2P video streaming that spans over multiple time zones but also in utilizing the surplus bandwidth, i.e., bandwidth in idle time zone.

This algorithm is suggested in the paper that does not considering the situation of varied Network. In fact, our using Network has not always existed in the same state, or the same state, it is not guaranteed. Changed state of Network can be a sudden problem. But, Similarly pattern of the bandwidth changes can predict.

The Multi-Hour Ability, suggested in the paper, is based on a similar pattern in network. That is based on Multi-Hour which means the bandwidth requirement is different each time at network. By using Multi-hour ability, reduce network traffic and each Peer to provide more bandwidth can be reliably. In addition to effectively use the surplus bandwidth, Multi-Hour Ability to improve the performance of the peer-to-peer streaming that it can prove through experiments. As a future work, suggested algorithm can experiment on real overlay Network. And can get more realistic results.

## 6. ACKNOWLEDGEMENT

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